

Appl. No. 10/050,246
Amendment dated May 26, 2004
Response to Notice of Allowance dated March 1, 2004

Amendments to the Claims

This listing of claims will replace all prior versions and listings of claims in the application:

Listing of Claims

1. (currently amended) A barrier stack comprising:
a first barrier layer having a top surface; ~~and~~
a thin intermediate layer on the top surface of the first barrier layer formed by a thermal process in an oxidizing ambient, the thin intermediate layer providing elements to stuff the grain boundaries on or near the top surface of the first barrier layer; and
a second barrier layer on the thin intermediate layer, wherein the grain boundaries of the first and second barrier layer are mismatched, the stuffed grain boundaries of the first barrier layer and mismatched grain boundaries of the first and second barrier layers enhance the barrier properties of the barrier stack.
2. (currently amended) The barrier stack of claim 1 wherein the barrier layer serves as a barrier layer for a capacitor over plug structure having:
a capacitor having a capacitor dielectric layer disposed between first and second electrodes; and
a plug electrically coupled to the first electrode wherein the barrier stack is disposed between the plug and the first electrode to reduce oxidation of the plug.
3. (previously presented) The barrier stack of claim 2 wherein the capacitor over plug structure further comprises an adhesion layer between the barrier stack and the plug.

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4. (currently amended) The barrier stack of claim 2 wherein the capacitor of the capacitor over plug structure comprises a ferroelectric capacitor having a ferroelectric layer disposed between the first and second electrodes.
5. (original) The barrier stack of claim 4 further comprises an adhesion layer between the barrier stack and plug.
6. (previously presented) The barrier stack of claim 1, 2, 3, 4, or 5 wherein the oxidizing ambient comprises oxygen, ozone or $\text{NO}_x(0 < x < 2)$ to form the intermediate layer comprising an oxide, the oxidizing ambient providing elements comprising oxygen.
7. (previously presented) The barrier stack of claim 6 further comprises a second thin intermediate layer on a top surface of the second barrier layer formed by thermal process in oxidizing ambient, the second thin intermediate layer providing elements to stuff the grain boundaries on or near the top surface of the second barrier layer.
8. (previously presented) The barrier stack of claim 7 wherein the thermal process comprises rapid thermal oxidation.
- 9-12. (cancelled)
13. (previously presented) The barrier stack of claim 6 wherein the thermal process comprises rapid thermal oxidation.

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14. (cancelled)

15. (previously presented) The barrier stack of claim 6 wherein the barrier layers comprise a material selected from the group of materials comprising Ir, Rh, Ru, Pd, or alloys thereof, wherein the first and second barriers are formed from same or different materials.

16-18. (cancelled)

19. (previously presented) The barrier stack of claim 13 wherein the barrier layers comprise a material selected from the group of materials comprising Ir, Rh, Ru, Pd, or alloys thereof, wherein the first and second barriers are formed from same or different materials.

20-22. (cancelled)

23. (previously presented) The barrier stack of claim 7 wherein the barrier layers comprise a material selected from the group of materials comprising Ir, Rh, Ru, Pd, or alloys thereof, wherein the first and second barriers are formed from same or different materials.

24. (previously presented) The barrier stack of claim 8 wherein the barrier layers comprise a material selected from the group of materials comprising Ir, Rh, Ru, Pd, or

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alloys thereof, wherein the first and second barriers are formed from same or different materials.

25-26. (cancelled)

27. (currently amended) A capacitor over plug structure comprising:
a capacitor having first and second electrodes separated by a capacitor dielectric layer;
a plug coupling the first electrode of the capacitor; and
a barrier stack disposed between the plug and the first electrode comprising:
a first barrier layer having a top surface;
an intermediate layer on the top surface of the first barrier layer formed by a thermal process in an oxidizing ambient, the thin intermediate layer providing elements to stuff the grain boundaries on or near the top surface of the first barrier layer; and
a second barrier layer on the thin intermediate layer, wherein the grain boundaries of the first and second barrier layer are mismatched, the stuffed grain boundaries of the first barrier layer and mismatched grain boundaries of the first and second barrier layers enhance the barrier properties of the barrier stack to reduce oxidation of the plug.

28. (previously presented) The capacitor over plug structure of claim 27 wherein the capacitor comprises a ferroelectric capacitor.

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29. (previously presented) The capacitor over plug structure of claim 27 or 28 wherein the oxidizing ambient comprises oxygen, ozone or NO_x ($0 < x < 2$), the thermal process forms the intermediate layer comprising an oxide and the oxidizing ambient provides elements comprising oxygen to stuff the grain boundaries.

30. (previously presented) The capacitor over plug structure of claim 29 wherein the thermal process comprises rapid thermal oxidation.

31. (previously presented) The capacitor over plug structure of claim 30 wherein the barrier layers comprise a material selected from the group of materials comprising Ir, Rh, Ru, Pd, or alloys thereof, the barrier layers can be formed from same or different materials.

32. (previously presented) The capacitor over plug structure of claim 29 further comprises a second intermediate layer on a top surface of the second barrier layer formed by thermal process in oxidizing ambient, the second intermediate layer providing elements to stuff the grain boundaries at or near the top surface of the second barrier layer.

33. (previously presented) The capacitor over plug structure of claim 32 wherein the barrier layers comprise a material selected from the group of materials comprising Ir, Rh, Ru, Pd, or alloys thereof, the barrier layers can be formed from same or different materials.

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34. (previously presented) The capacitor over plug structure of claim 33 wherein the thermal process comprises rapid thermal oxidation.

35. (currently amended) The capacitor over plug structure of claim 27 or 28 wherein the barrier layers comprise a material selected from the group of materials comprising Ir, Rh, Ru, Pd, or alloys thereof, the barrier layers can be formed from same or different materials.

36. (previously presented) The capacitor over plug structure of claim 29 wherein the barrier layers comprise a material selected from the group of materials comprising Ir, Rh, Ru, Pd, or alloys thereof, the barrier layers can be formed from same or different materials.

37-56. (cancelled)

57. (new) The capacitor over plug structure of claim 27 or 28 wherein the thermal process forms the intermediate layer comprising an oxide and the oxidizing ambient provides elements comprising oxygen to stuff the grain boundaries.

58. (new) The capacitor over plug structure of claim 57 wherein the thermal process comprises rapid thermal oxidation.

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59. (new) The capacitor over plug structure of claim 58 wherein the barrier layers comprise a material selected from the group of materials comprising Ir, Rh, Ru, Pd, or alloys thereof, the barrier layers can be formed from same or different materials.

60. (new) The capacitor over plug structure of claim 57 further comprises a second intermediate layer on a top surface of the second barrier layer formed by thermal process in oxidizing ambient, the second intermediate layer providing elements to stuff the grain boundaries at or near the top surface of the second barrier layer.

61. (new) The capacitor over plug structure of claim 60 wherein the barrier layers comprise a material selected from the group of materials comprising Ir, Rh, Ru, Pd, or alloys thereof, the barrier layers can be formed from same or different materials.

62. (new) The capacitor over plug structure of claim 61 wherein the thermal process comprises rapid thermal oxidation.

63. (new) The capacitor over plug structure of claim 60 wherein the thermal process comprises rapid thermal oxidation.

64. (new) The capacitor over plug structure of claim 57 wherein the barrier layers comprise a material selected from the group of materials comprising Ir, Rh, Ru, Pd, or alloys thereof, the barrier layers can be formed from same or different materials.